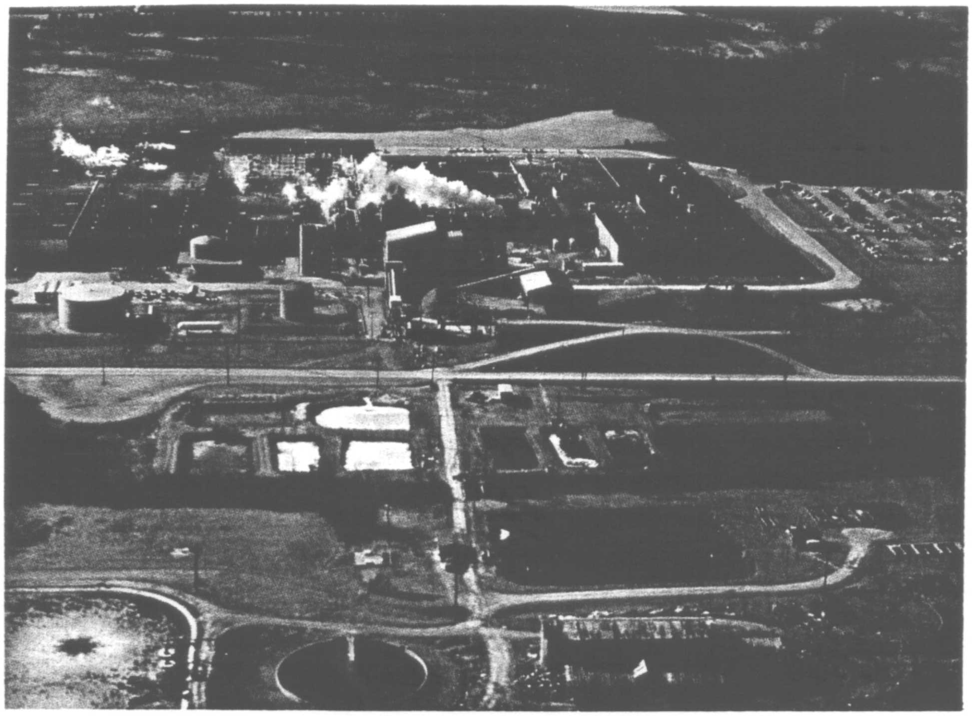
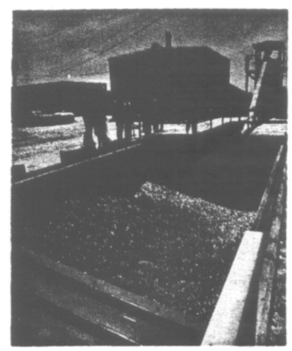
GEORGIA FOREST RESEARCH PAPER

45

OCTOBER, 1983





THE ENERGY USE OF WOOD IN GEORGIA

by

Robert L. Chaffin and
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GEORGIA FORESTRY COMMISSION

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Forest Products Industry

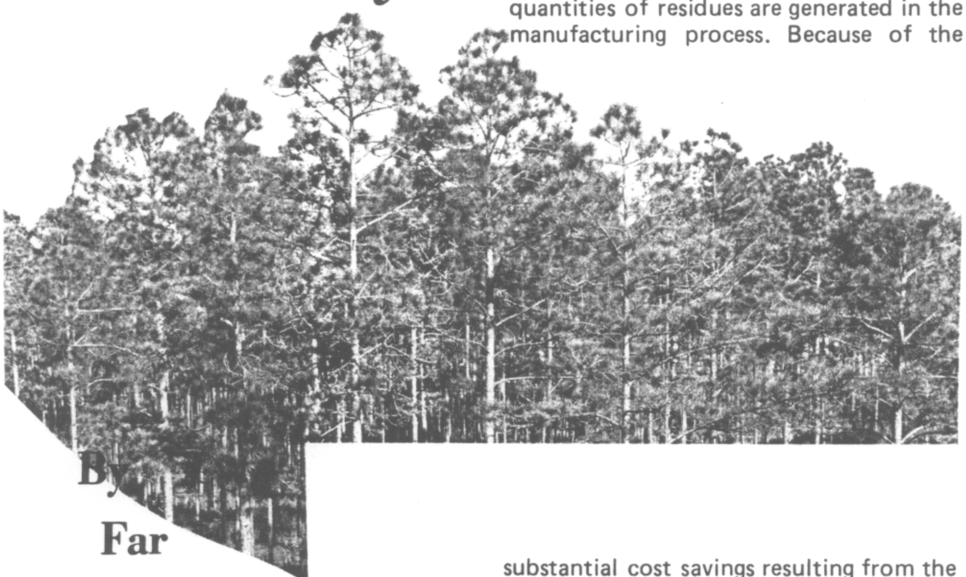
By Far The Largest User Of Wood For Energy

by
Robert L. Chaffin* and *Albert A. Montgomery

By far the largest user of wood for energy in Georgia is the forest products industry itself. In 1981, this industry utilized 8.5 million tons of wood fuel as well as an undetermined but large quantity of black pulping liquor. The annual fuel cost savings attributable to the substitution of wood for conventional fuels by industry, government, and households totals nearly $500 million.

Forest product manufacturers are energy intensive, with energy costs accounting for as much as 40 percent of the total operating costs of these firms. Among interviewed firms, the savings of fuel cost were cited most frequently as the reason for substituting wood for conventional fuels. In addition to the cost incentive, wood fuel will technically substitute for any conventional fuel previously used by the firm.

Wood is an inexpensive fuel source to the forest products industry since large quantities of residues are generated in the manufacturing process. Because of the



substantial cost savings resulting from the use of wood fuel, the firms interviewed in this study plan to install additional wood burning capacity in excess of 650,000 tons by 1985.

While the huge energy requirements of the forest products industry will continue to dominate the demand for wood fuel in Georgia, other Georgia manufacturers, state institutions, and schools are turning increasingly to wood as a major energy source, utilizing more than 400,000 tons in 1981. Moreover, home owners in Georgia increased their use of firewood by 30 percent from 1979 to 1981 to more than 4 million tons or 1.6 million cords.

Georgia's potential supply of wood for energy is abundant in relation to current and anticipated demand. The demand for wood energy constitutes no serious competition for the timber requirements of lumber mills, pulp and paper mills, and other forest product manufacturers. As the principal consumer of wood for fuel, the forest products industry obtains most of its wood energy from manufacturing residues as contrasted with in-the-woods produced fuel chips, which account for less than 7 percent of its current use.

A largely untapped source of wood for energy is the estimated 22 tons of wood waste per acre remaining after logging operations. Based on an annual timber harvest of 640,000 acres, this source alone could supply 14 million tons of wood fuel annually or more than three times as much wood as is currently being removed from the forest in the form of firewood or fuel chips. Moreover, Georgia's forest contains an estimated 90 million tons of cull trees that have little or no value except as wood fuel.

Judging from the whole tree chipping operators interviewed in the study, about 30 percent of the in-the-woods chip production is for fuel. The interviewed firms also indicated that they expected to expand their capacity to produce fuel chips by as much as 20 percent within the forseeable future. This implies that while a very large investment in equipment is required for in-the-woods chipping, these firms are willing to expand their operations as much as justified by the growth of the market.

On the other hand, this market for fuel chips is still very small and, thus, the beneficial impact of in-the-woods of whole tree chipping on forest management at present is also slight.

Currently, much less than 10 percent of all timberland being harvested has been benefited by the waste-clearings effect of whole tree chipping and some of this chipped over land has reverted to agricultural and other uses. However, if the demand for wood fuel chips continues its recent growth into the future, there will eventually be a significant impact on the cost of forest management in that the reforestation of chipped-over land costs only one-fourth to one-third as much as that of conventionally harvested timberland.

Wood is Georgia's least costly energy alternative. Wood energy is used widely in heating homes and public buildings, in drying agricultural crops and manufactured products, and in producing steam, heat, and electricity for manufacturing applications. Georgia industry, government, and households burned 13.1 million tons of wood chips, residues, and roundwood for energy in 1981, Table 1.

The energy produced by burning these quantities of wood fuel was equivalent to 17.9 million barrels of fuel oil and resulted in a saving for users of $495 million as compared with the cost of conventional fuels.

In addition to the fuel savings, the substitution of wood energy by Georgia industry, government, and households resulted in an estimated $44 million of additional economic activity in Georgia. Wood fuel is a renewable, locally produced energy source as contrasted with conventional fuels which must be imported into the state. For every 1,500 tons of chips produced for fuel, it is estimated that one job is directly or indirectly created in Georgia.

METHODOLOGY

To determine the characteristics and demands of users of wood energy, interviews were conducted with 35 lumber and wood products firms, 11 pulp, paper and board mills, and two nonwood industries. The wood energy use and experience of lumber and wood products firms, and pulp, paper and board mills are stressed in this report, since these industries are the major users of wood fuel in Georgia. Summary data were collected on wood energy used by state institutions, hospitals, and public school systems. The later analysis of the supply of wood chips for energy use was based on interviews with 11 in-the-woods whole tree chipping operations.

Energy Sources

Each forest products firm interviewed used a variety of energy sources, Table 2. Wood residues furnished from 12 to 100 percent of the energy requirements of lumber and wood products firms. Other energy sources in order of importance among lumber and wood products firms were electricity, natural gas, propane gas (LPG) and fuel oil. Pulp, paper and board mills also used coal and coke and burned black liquor as a primary fuel. Among Georgia mills, wood energy accounted for 5 to 90 percent of all energy requirements.

Forest products firms are energy intensive. Energy expenditures by 31 lumber and wood products firms totaled $13.4 million in 1981, averaging $432,140 per firm, Table 3. Energy costs ranged upward to 40 percent of total operating costs for these firms. Operating costs of wood burning systems at these mills totaled $3,298,000, equal to 24.6 percent of total energy costs.

Pulp, paper and board mills are especially large users of energy. The seven mills supplying cost data spent $192.6 million on energy in 1981, ranging from a high of $50 million to a low of $15 million. Energy costs represented between 14 and 30 percent of total operating costs at the responding mills. Mills spent an average of $5.4 million in operating their wood burning systems.

Georgia's forest products firms use wood energy to generate steam, heat, and electricity for manufacturing applications. Lumber and wood products mills typically burn wood to generate steam and heat, while pulp, paper and board mills use wood to produce steam, heat, and electricity, Table 4.

Because of substantial and costly energy requirements, forest products firms self-generate a meaningful proportion of total energy requirements. Wood residues from lumber and wood products manufacturing operations are the only fuels used by lumber and wood products firms to self-generate steam and heat, Table 5. These firms self-generate from 20 to 80 percent of total energy consumption, with the remainder represented by purchases of electricity, fuel oil, natural gas and LPG.

Pulp, paper and board mills purchased between 3 and 61 percent of total energy requirements, and self-generated 4 to 45 percent of needs using wood residues and chips. Fuels other than wood used by these mills to generate steam, electricity, and heat accounted for 36 to 72 percent of total energy consumption.

All pulp mills in Georgia burn black pulping liquor as a fuel. This indigenous energy source provided between 31 and 55 percent of the total energy requirements of Georgia mills in 1981. The typical mill utilized 100 percent of the available black liquor waste as fuel.

Demand for Chips and Residues

The use of residues for wood energy is far more prevalent than the use of chips by forest products industries in Georgia. The 29 reporting lumber and wood products firms used 883,000 tons of residues in 1981, while 3.5 million tons were burned by pulp, paper and board mills, Table 6. Using an average of 313,783 tons of residues, the representative pulp, paper and board mill in Georgia burns 10.3 times the quantity of residues used for wood energy by a lumber and wood products firm. Chips were burned for wood energy by a single lumber and wood products firm and by five pulp, paper and board mills. Chips fuel consumption represented less than seven percent of the total use of wood residues by Georgia's forest products industries.

The delivered price per ton for wood residues varied widely, from $2.48 to $26.00 per ton at 14 lumber and wood products firms, and from $6.23 to $28.20 at eight pulp, paper and board mills, Table 7. The weighted average price for residues was $11.00 at lumber and wood products firms and $12.94 at pulp, paper and board mills.

TABLE 1

Wood Energy Used by Georgia Industry, Government and Households, 1981

User	Wood Fuel Tons	Wood Fuel Cost	Equivalent Fuel Oil Cost	Savings
Lumber and Wood Products	4,382,700	$ 48,209,300	$245,917,700	$197,708,400
Pulp, Paper and Board Mills	4,107,600	53,633,000	230,482,200	176,849,200
Nonwood Industry	295,800	3,253,500	16,596,400	13,342,900
Government Institutions	111,000	1,665,700	6,231,100	4,565,400
Households	4,238,000	135,597,800	237,798,200	102,200,400
Total	13,135,100	$242,359,300	$737,025,600	$494,666,300

The total imputed cost of wood fuel used to generate energy was $11.6 million at 30 lumber and wood products firms and $47.3 million at 11 pulp, paper and board mills. Since one ton of wood is equal in heating value to 1.36 barrels of fuel oil, the fuel oil cost to generate equivalent energy in 1981 would have been $55.1 million for these lumber and wood products firms and $203.2 million at the pulp, paper and board mills interviewed.

The kind of wood used for wood energy was directly associated with the kind of wood processed by lumber and wood products firms. Among these firms, 21 used pine for wood energy production, 7 used hardwood residues, and 7 used both pine and hardwood, Table 8. Pine was the wood energy material preferred by 74 percent of the firms interviewed.

Pulp, paper and board mills typically used both pine and hardwood for the production of wood energy. Pine alone was used by only three mills. In turn, these mills did not stipulate an overriding preference as to the kind of wood burned for wood energy; four expressed a preference for pine, three for hardwood, and three had no preference.

Wood energy is considered to be a viable substitute for five conventional fuels: electricity, coal and coke, fuel oil, natural gas, and LPG. Among lumber and wood products firms, wood energy is considered an alternative to fuel oil by 54 percent of the plants interviewed, and to natural gas by 57 percent of respondents, Table 9. More than 30 percent of lumber and wood products firms contend that wood energy can substitute for electricity, LPG, and coal and coke. Since none of the lumber and wood products firms interviewed used coal and coke, wood energy is considered to be a substitute fuel for fuel oil by 82 percent of responding pulp, paper and board mills, for natural gas by 55 percent, and for coal and coke by 55

Indeed, wood energy has been used extensively in Georgia to reduce high energy costs associated with alternative fuels. Among lumber and wood products firms, 11 report that the expanded use of wood energy has reduced fuel oil bills by 28 to 100 percent, and 12 report a reduction in natural gas costs by 25 to 100 percent. The use of wood energy to displace fuel oil has been significant among pulp, paper and board mills, where four mills recorded cost reductions ranging from 60 to 45 percent.

As an indicator of potential wood energy demands, firms were queried as to the percent of energy requirements now provided by conventional fuels that could be supplied by alternative fuels. With appropriate systems investment, wood energy was considered by lumber and wood products firms to be a feasible alternative for 25 to 100 percent of electrical energy requirements by 11 firms, 75 to 100 percent of fuel oil requirements by 9 firms,

TABLE 2

Energy Sources Used by Firms That Utilized Wood Energy in 1981

Source	Number	Percent of Total Energy Requirements High	Low
LUMBER AND WOOD PRODUCTS			
Electricity	34	85	13
Coal and Coke	0		
Fuel Oil	3	5	5
Natural Gas	11	35	1
LPG	5	2	0.2
WOOD	35	100	12
PULP, PAPER, AND BOARD MILLS			
Electricity	10	13	1
Coal and Coke	4	32	10
Fuel Oil	9	27	1
Natural Gas	7	30	0.1
LPG	2	1	0.2
Black Liquor	9	62	31
WOOD	10	90	5

TABLE 3

Energy Expenditures by Firms Utilizing Wood Energy

Expenditures	Lumber and Wood Products	Pulp, Paper and Board Mills
Total Energy Costs:		
Number of Firms	31	7
Total Expenditures	$13,396,330	$192,599,000
Average Energy Cost	432,140	27,514,143
Range: High	1,500,000	50,000,000
Low	18,000	15,000,000
Total Operating Costs of Wood Burning System:		
Number of Firms	30	6
Total Expenditures	$ 3,298,000	$ 32,106,000
Average Operating Cost	109,933	5,351,000
Range: High	430,000	12,000,000
Low	15,000	300,000
Percent of Total Operating Costs Represented by Energy Costs:		
High	40%	30%
Low	1	14

and 20 to 100 percent of natural gas requirements by 12 firms, Table 10. Wood energy could also displace up to 100 percent of coal and coke and LPG requirements, although these fuels were insignificant energy sources among the 35 firms interviewed.

Wood energy was a preferred alternative to fuel oil consumption among pulp, paper and board mills. Among the nine mills currently using fuel oil, six mills stated that wood energy could supply 5 to 100 percent of the energy requirements now generated by this conventional fuel. Similarly, three mills estimated that wood could displace 21 to 100 percent of the energy requirements now provided by coal and coke.

Major Reasons for Converting to Wood Energy

Each respondent was asked to rank in order of importance the major reasons that influenced their firm to convert a portion of its energy requirements from conventional sources to wood. Reasons that did not influence the decision were not ranked.

The reason that energy sources other than wood were becoming too expensive was ranked first by 38.2 percent of the lumber and wood products firms and 50.0 percent of the pulp, paper and board mills, Table 11. This reason was ranked second by 21.9 percent of the lumber and wood products firms and 30.0 percent of pulp, paper and board mills.

The ready availability of wood for energy at competitive cost was the second most significant reason for converting from conventional energy sources to wood. This reason was ranked first by 29.4 percent of the lumber and wood products firms interviewed and second by 28.1 percent. Among pulp, paper and board mills, this reason was ranked both first and second by 20.0 percent of the respondents. Combined, the above two reasons accounted for 67.6 percent of the first ranked reasons and 50.0 percent of the second ranked reasons by lumber and wood products firms. Among pulp, paper and board mills, these reasons were ranked first by 70.0 percent and second by 50.0 percent of the mills interviewed.

The impetus to become energy independent by converting to wood was not a significant first or second reason among lumber and wood products firms. This reason was ranked second in importance by 20.0 percent of the pulp, paper and board mills.

Planned Investments in Wood Energy Systems

Based on a past favorable experience in using wood energy, nine lumber and wood products firms planned an additional investment in their wood energy system or equipment during the 1982 through 1985 period, Table 12. These planned expansions would increase wood energy requirements by 175,500 tons per year. When completed, the percent of total energy requirements supplied by wood will rise to 30 to 100 percent among the nine firms, up from 20 to 55 percent currently. Depending on the proposed wood burning system improvement or expansion, it was estimated that 1 to 10 years would be required for the investment to pay for itself in energy cost savings.

Among the pulp, paper and board mills interviewed, four mills indicated additional investments would be made over the next three years in their wood energy system. As proposed, this expanded reliance on wood energy would increase annual wood consumption by 493,000 tons. Wood energy will comprise 23 to 45 percent of total energy needs at these four mills after expansion, contrasted with 15 to 41 percent currently. These mills estimated a 1.5 to 5 year payback period over which energy cost savings will amortize investment costs.

Future Demands for Wood Energy

Based on open-ended responses, a number of conditions were cited by respondents that will cause Georgia industry to expand the use of wood as a source of energy. Those firms currently using wood energy understood well the cost savings over conventional fuels associated with wood. Since energy economics clearly favor wood, further increases in fuel and power prices will accelerate the expanded use and conversion to wood energy. This condition was stated by 22 lumber and wood products firms, 9 pulp, paper and board mills, and 6 whole tree chipping operations, Table 13.

Among the firms interviewed, five lumber and wood products firms and three pulp, paper and board mills were concerned about the reliability of the supply of wood for energy. These firms indicated that a certain and dependable source of chips and residues would lead to an expanded demand for wood energy.

Three lumber and wood products firms expressed some concern that their industry needs to become more knowledgeable about the cost savings associated with the use of wood energy. Two pulp, paper and board mills and two whole tree chipping operations stated that technological improvements in the harvesting and transporting of wood fuel would lead to increased demands for wood as a source of energy.

Homeowners in Georgia increased their use of firewood by 30 percent from 1979 to 1981 to more than 4 million tons or 1.6 million cords.

Supply of Chips and Residues

Wood for energy is procured from five sources by Georgia's industry:

1. Independent contractors from private lands
2. Residues from other forest products manufacturers
3. Company lands
4. Company sawmill operations

Wood residues from company mill operations were the sole wood energy sources at 28 of 35 lumber and wood products firms interviewed, Table 14. This source plus residues from other forest products manufacturers accomodated the wood energy requirements of 89 percent of the lumber and wood products firms. Independent contractors supplied only nominal quantities of wood energy residues and chips to these firms.

Residues from company mill operations and other forest products manufacturers comprise the principal sources of wood energy supplies for pulp, paper and board mills. Outside residues are obtained, typically, from other forest products manufacturers that are operating units of the parent corporation of the pulp, paper and board mill.

Wood energy originating from private lands and furnished by private contractors was a supplemental source used by only three lumber and wood products firms and three pulp, paper and board mills. None of the 35 lumber and wood products firms interviewed conducted in-the-woods whole tree chipping operations for wood energy chips. While three of the interviewed pulp, paper and board mills maintained whole tree chipping operations in-the-woods, a single mill produced hardwood and softwood chips for use as wood energy.

Among the wood energy users interviewed, chip fuel consumption totaled 380,639 tons in 1981. Chip fuel is a growing source of energy at state institutions and schools and at pulp, paper, and board mills. Wood residues are the prevalent form of wood energy used by lumber and wood products firms in Georgia.

Chip Production

To determine the characteristics and experience of fuel chip producers, 11 whole tree chipping operations in Georgia were interviewed. These firms produced a mix of wood outputs, including fuel and pulp chips, pulpwood and sawlogs. In 1981 the 11 operations produced 199,983 tons of whole tree fuel chips and 455,316 tons of whole tree pulp chips, equivalent to 262,100 cords of wood, Table 15. In addition to chips, these firms produced 233,368 MBF of sawlogs and three operations produced small cordages of pulpwood.

The chip production of the 11 whole tree chipping operations interviewed can be allocated as 240,350 tons of hardwood chips and 414,949 tons of softwood chips. Timberlands owned by nonindustrial landowners were the origin for 173,684 tons of chips, while 481,615 tons originated from timberlands owned by forest industries. In producing these chip tonnages the chipping operations clear cut 14,612 acres and selectively cut 612 acres of timberland.

Whole tree chipping operations paid from $2.00 to $9.60 per ton for whole tree chipping stumpage. On a per acre basis, the stumpage payments ranged from a low of $95.00 to a high of $336.00.

Whole tree chipping is a forest management tool that can upgrade low-value natural stands, maximized forest outputs, and significantly reduced site preparation costs. Since most whole tree chipping uses the clear cutting harvesting technique, land can be planted readily at a cost of about $40 to $50 per acre in Georgia. This contrasts with an estimated $170 to $200 per acre to site prepare and plant pines on timberland that is harvested by conventional methods.

In-the-Woods Whole Chip Production

In 1981 chip using firms and institutions bought 365,921 tons of chips from the 11 in-the-woods chips producers interviewed, equal to 56 percent of chip sales. Chips produced under contract from forest industry land and delivered to the company accounted for 289,378 tons or 44 percent of chip sales.

The delivered prices for in-the-woods whole tree chips received by producers ranged between $14.00 and $25.00 per ton for pulp chips and between $10.80 and $17.50 for wood energy chips. The price per ton for chips produced and delivered under contract from company lands ranged from a low of $13.58 to a high of $17.50 per ton.

TABLE 4

Firms Using Wood Energy to Generate Steam, Electricity, and Heat

	Lumber and Wood Products	Pulp, Paper, and Board Mills
Number of Firms Using Wood Energy to Generate:		
Steam	19	2
Heat	6	
Steam and Heat	10	
Steam and Electricity		6
Steam, Electricity and Heat		3
Total	35	11

TABLE 5

Purchased and Self-Generated Energy by Georgia Firms

	Lumber and Wood Products	Pulp, Paper, and Board Mills
Purchased:		
Number of Firms	33	11
Range: High	100%	61%
Low	13	3
Self-Generated from Wood:		
Number of Firms	33	11
Range: High	80%	45%
Low	20	4
Self-Generated from Other Fuels:		
Number of Firms	0	11
Range: High		72%
Low		36

Counties in Which In-the-Woods Chips Were Produced and Sold

Based on data from responding operations, 604,329 tons of chips were produced in 33 Georgia counties, Table 16. More than half the chip production in 1981 was concentrated in seven counties which recorded an output of 25,000 tons or more:

County	Chip Production
Crawford	74,000 tons
Talbot	64,900
Macon	50,000
Laurens	37,900
Camden	35,500
Monroe	25,900
Bartow	25,000

Only two counties were reported as having in-the-woods chipping locations by more than one chipping operation.

Sales of 573,559 tons of whole tree chips were concentrated in eight Georgia counties, Table 17. Recording sales of more than 50,000 tons each, Bibb, Floyd, and Macon counties represented more than 80 percent of sales by the whole tree chipping operations interviewed. Bibb County alone accounted for chip sales of 338,400 tons by five chipping operations, equal to 59 percent of total sales by the operations interviewed. The concentration of chip sales in a relatively few counties is explained by the location in these counties of major chip consuming industries and institutions.

In 1981, three Georgia whole tree chipping operations produced 29,240 tons of chips in Florida and South Carolina for delivery to Georgia firms and institutions; 71 percent of these chips produced out-of-state were used for wood energy. Although 61,000 tons of whole tree chips were produced in Georgia and sold in Alabama, none were used in generating wood energy.

In-the-Woods Chip Production and Equipment Requirements

The 11 Georgia in-the-woods whole tree chipping operations interviewed had the capacity to produce 733,400 tons of softwood and hardwood chips during a 200 working days year. Actually producing 655,299 tons of chips, these firms operated at 89.4 percent of output capacity.

The production capacities of individual chipping operations ranged from a low of 88 tons per day to a high of 1,200 tons per day. The combined chipping capacity of the 11 firms interviewed was 3,667 tons per eight hour day.

The chipping operations interviewed employed 150 workers. Chip production per worker varied between 10.5 and 30.0 tons per day. Operations with a larger daily chipping capacity tended to have a higher output per worker day.

To produce 655,299 tons of chips in 1981, the 11 Georgia operations utilized the equipment listed in Table 18. The typical chipper used by a whole tree chipping operation had a 22 inch maximum log diameter size and produced 46,800 tons of chips in 1981. Each chipper was fed by two skidders and 2.3 feller bunchers. The output of a single chipper was transported by 6 chip trailers. The investment in the chipper and other supporting equipment will range from about $500,000 mimimum to well over $1,000,000. An investment of this magnitude requires operation at near capacity levels and quality management.

At the chipping site, 6 chipping operations sorted out the material by sawtimber, pulpwood, and other harvests, while 5 operations did not sort harvested material.

Among the 11 firms interviewed, five chipping operations shipped all production by owned chip trucks, while six operations delivered 4 to 60 percent of chip shipments by leased chip trucks. The maximum hauling distance for whole tree chips destined for fuel use ranged from a low of 25 miles to a high of 70 miles. The maximum transport distance for pulp chips was 150 miles.

Expansion Plans

The in-the-woods whole tree chipping operations interviewed expanded capacity from 642,200 tons in 1979 to 733,400 tons in 1981, a gain of 14.2 percent. Among the eight firms expanding production the increase in chipping capacity ranged from 10.0 to 100.0 percent. One firm reported a decrease in chip production over the three year period,

Three Georgia whole tree chipping operations have plans to expand output by a total of 42,500 tons per year. Based on existing expansion plans, the production of wood energy chips would increase by 39,000 tons annually. This nominal increase in chip tonnages falls far short of the anticipated increases in wood energy consumption by 175,500 tons among Georgia's lumber and wood products firms and 493,000 tons by pulp, paper and board mills through 1985.

From the whole tree chipping operators interviewed in the study, about 30 percent of the in-the-woods chip production is for fuel.

TABLE 6

Residues and Chips Used for Wood Energy by Georgia Firms

	Lumber and Wood Products	Pulp, Paper, and Board Mills
Residues:		
Number of Firms	29	11
Total Tons	882,514	3,451,612
Range: High	180,000	625,000
Low	150	50,000
Average Tons	30,432	313,783
Chips:		
Number of Firms	1	5
Total Tons	(D)	169,590
Range: High	(D)	(D)
Low	(D)	(D)
Average Tons	(D)	33,918

(D) Data not reported.

TABLE 7

Price Per Ton for Residues and Chips Used for Wood Energy by Georgia Firms

Delivered Price Per Ton:	Lumber and Wood Products	Pulp, Paper, and Board Mills
Residues:		
Number of Firms	14	8
Range: High	$26.00	$28.20
Low	2.48	6.23
Weighted Average	11.00	12.94
Chips		
Number of Firms	1	2
Range: High	(D)	(D)
Low	(D)	(D)
Weighted Average	(D)	(D)

TABLE 8

Kind of Wood Used and Preferred for Wood Energy

	Lumber and Wood Products	Pulp, Paper, and Board Mills
Number of Firms Using:		
Pine Only	21	3
Hardwood Only	7	0
Pine and Hardwood	7	8
Total	35	11
Number of Firms Preferring:		
Pine	26	4
Hardwood	8	3
No Preference	1	3
Total	35	10

TABLE 9

Wood Energy as a Substitute for Conventional Fuels

Conventional Sources	Number	Firms Percentage of Respondents
LUMBER AND WOOD PRODUCTS:		
Electricity	11	31.4
Coal and Coke	11	31.4
Fuel Oil	19	54.3
Natural Gas	20	57.1
LPG	12	34.3
PULP, PAPER, AND BOARD MILLS:		
Electricity	3	27.2
Coal and Coke	6	54.5
Fuel Oil	9	81.8
Natural Gas	6	54.5
LPG	2	18.2

TABLE 10

Percent of Total Energy Requirements Supplied by Conventional Fuels That Could Be Supplied by Wood Energy

Conventional Sources	Number of Firms	Range of Energy Requirements That Could be Supplied by Wood: High	Low
LUMBER AND WOOD PRODUCTS:			
Electricity	11	100%	25%
Coal and Coke	3	100	100
Fuel Oil	9	100	75
Natural Gas	12	100	20
LPG	5	100	10
No Opinion	6		
PULP, PAPER AND BOARD MILLS:			
Electricity	1	100	100
Coal and Coke	3	100	21
Fuel Oil	6	100	5
Natural Gas	2	50	30
LPG	0		
No Opinion	0		

TABLE 11

Opinions

Major Reasons for Converting Energy Requirements from Conventional Sources to Wood Energy

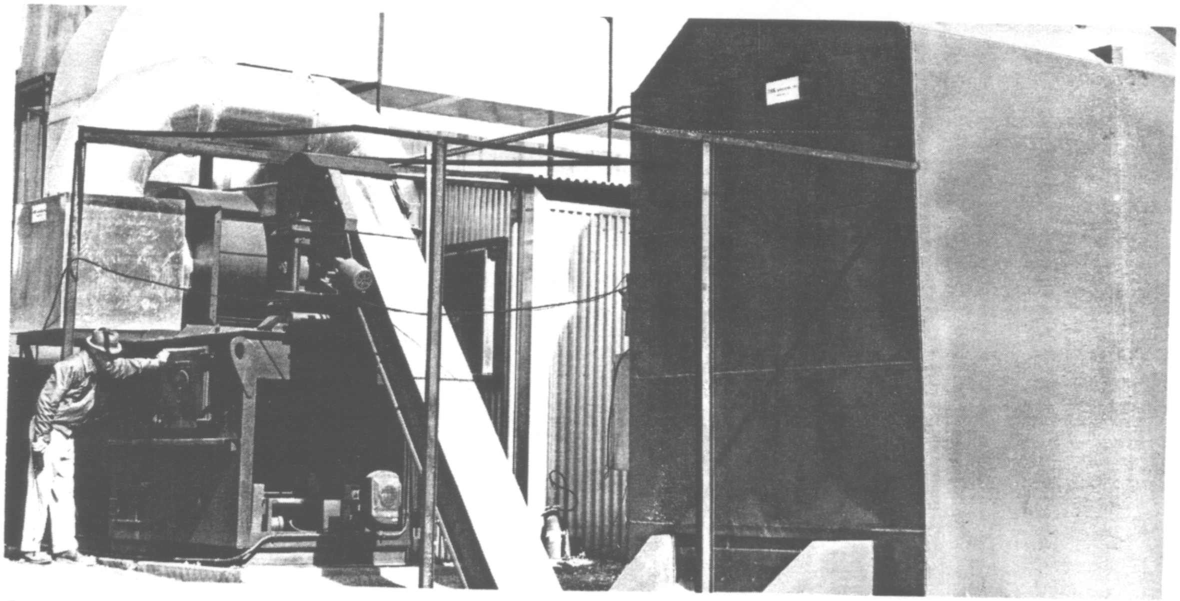
Percent of Responses Ranking No. 1 and No. 2

	Respondent			
	Lumber and Wood Products		Pulp, Paper, and Board Mills	
Reason	% of 1's	% of 2's	% of 1's	% of 2's
Other energy sources were becoming too expensive	38.2	21.9	50.0	30.0
Supply of wood for energy was readily available at competitive cost	29.4	28.1	20.0	20.0
Cheaper to burn wood for fuel than to dispose of it otherwise	14.7	28.1	30.0	10.0
Investment in wood burning equipment will pay for itself in a few years	11.8	15.6		20.0
Our business wanted to become energy independent	5.9	6.3		20.0
Total Responses:				
Percent	100.0	100.0	100.0	100.0
Number	34	32	10	10

TABLE 12

Characteristics of Firms That Plan an Additional Investment in Wood Energy Systems or Equipment

	Lumber and Wood Products	Pulp, Paper and Board Mills
Number of Firms	9	4
Tons of Wood Used per year		
Currently	360,500	2,052,700
After Expansion	536,000	2,545,700
Percent of Total Energy Requirements from Wood:		
Currently: High	55	41
Low	20	15
After Expansion: High	100	45
Low	30	23
Number of Years to Pay off Investment in Energy Savings:		
High	10.0	5.0
Low	1.0	1.5



Forest product manufacturers are energy intensive, with energy costs accounting for as much as 40 percent of the total operating costs of these firms.

TABLE 13

Conditions That Will Cause Georgia Industry to Increase Demands for Wood as a Source of Energy

Condition	Number of Times Mentioned by: Lumber and Wood Products Firms	Pulp Paper and Board Mills	Whole Tree Chipping Operations
If fuel and power prices continue to rise	22	9	6
If boiler efficiency is increased	3		
If mill production expands	2	1	
If the supply of wood for energy use becomes more reliable	5	3	
If natural gas service is increasingly interrupted	1		
If industry becomes more knowledgeable about savings associated with the use of wood energy	3		
If industry and landowners understand the savings in site preparation costs associated with chipping wood for energy in the field	1		
If technology is improved in the harvesting and transporting of wood fuel		2	2
If further environmental restrictions are imposed on the use of coal		1	
If the cost of producing chips for energy is brought down to the cost of producing chips for pulp			1

TABLE 14

Source of Supply of Wood Used for Energy

Source[1]	Lumber and Wood Products Number	Lumber and Wood Products Percent	Pulp, Paper, and Board Mills Number	Pulp, Paper, and Board Mills Percent
4	28	80.0	1	9.1
2	1	2.9		
2,4	3	8.6	4	36.4
1,3	1	2.9		
1,4	1	2.9		
2,3			1	9.1
1,2,3	1	2.9		
1,2,4			1	9.1
2,3,4			1	9.1
2,4,5			1	9.1
1,2,3,4			2	18.2
Total	35	100.2	11	100.1

[1] Description of Sources:

1. Independent Contractors from Private Lands
2. Residues from Other Forest Products Manufacturers
3. Company Lands
4. Wood Residues from Company Mill Operations
5. Company Sawmill Residues

TABLE 15

Quantities of Primary Forest Products Produced
by 11 Whole Tree Chipping Operations in Georgia, 1981

Product	Units Produced	
Whole Tree Fuel Chips	199,983 tons	79,993 cords
Whole Tree Pulp Chips	455,316 tons	182,126 cords
Pulpwood	3,750 cords	
Sawlogs	233,368 MBF	

TABLE 16

Georgia Counties in Which Whole Tree Chips Were Produced by Whole Tree Chipping Operations

Production (tons)	Number of Counties	Total Tons of Chips
50,000 and more	3	198,149
25,000 - 49,999	4	124,220
15,000 - 24,999	8	144,952
10,000 - 14999	6	68,110
5,000 - 9,999	7	56,246
Under 5,000	5	12,652
Total	33	604,329

TABLE 17

Georgia Counties in Which Whole Tree Chips Were Sold by Whole Tree Chipping Operations

Sales (tons)	Number of Counties	Total Tons of Chips
50,000 and more	3	474,963
25,000 - 49,999	2	87,346
15,000 - 24,999		
10,000 - 14,999	1	11,200
Under 10,000	2	50
Total	8	573,559

TABLE 18

Equipment Used by 11 Whole Tree Chipping Operations in Georgia

Type	Number	Tons of Chips Per Unit of Equipment
Chippers	14	46,807
Feller Bunchers	32	20,478
Skidders	28	23,404
Truck Tractors	60	10,922
Chip Trailers	84	7,801
Maintenance Trucks	18	36,406
Pickup Trucks	27	24,270
Other Vehicles	9	72,811

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GEORGIA FORESTRY COMMISSION

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J. Fred Allen, Chief of Forest Research

Cost $4,336.
Quantity 5M